

Inspire Form 실전 (3) - Stamping Material

한국알테어 • 김성문 기술사 • 2019-05-15



# 웨비나 순서

- Altair Inspire Platform
- Material Definition



# **Altair Inspire Platform**

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# Altair Inspire - From Studio To Manufacturing



The industry's most powerful and intuitive solution for design engineers to create high performing and manufacturable products.

# What Is Altair Inspire Form?

A streamlined stamping simulation software to

- •Design better products with early check for forming feasibility
- •Reduce scraps and improve material utilization
- Improve productivity with accurate formability analysis
- •Optimize the process through single and multistage virtual tryout



# Feasibility (1-step)

- 1. Use part CAD no meshing required
- Material database with US, Japanese and European standards
- 3. Automatic orientation to minimize undercuts
- 4. Apply blank holding force and drawbeads
- 5. Visualize thinning, formability, strains
- Automatic blank fit and nesting to save material cost



### Feasibility Workflow

Quickly and reliably check the formability of the part early in the design phase by predicting potential for splits, wrinkles and loose metal.

The geometry of the flat blank can be automatically fitted inside regular shapes such as rectangle and trapezoid as well as nested on a sheet coil for maximum material utilization.



# Virtual Tryout (Incremental)

- Intuitive and efficient environment for single and multi-stage stamping simulation.
- 2. Highly scalable solver for accurate forming and springback analyses
- Thinning, strain, stress, failure contours and Forming Limit Diagram
- 4. Plot of tool force versus stroke
- 5. Callouts to view results history at any location



# **Tryout Workflow**

Intuitively setup complex stamping processes including gravity, draw, redraw, flanging and springback with all tools and blanks.

Iterate on blank holder force and drawbead location and force to improve part quality.



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# **Material Test**

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# **Sheet Material Behavior**





$$\sigma_T = K \varepsilon_T^n$$
 or  $\sigma_T = \sigma_o + K \varepsilon_T^n$   
 $\sigma = K (\varepsilon_o + \overline{\varepsilon})^n$ 

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Inspire Form, v2018

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## **Sheet Material Behavior**

Sheet Material Behavior - Anisotropy





Rolling process causes orthotropy in sheet metal

Plastic strain ratio R from Tensile test

Quantify anisotropy in sheet metal

## **Sheet Material Behavior**

Sheet Material Behavior - Forming Limit diagram



- A plot of Major and Minor strain
- Location on the plot gives information of mode of deformation



• Limit curve obtained from experiments gives the forming limit of material beyond which it fails.



Captures all deformation modes

# **Inspire Form Material Definition**

# Feasibility / Tryout: Materials

- Materials Create a material that is based on an existing predefined material in the System Library.
- **Orient -** Use the Orient tool to orient the stamping direction for a part.
- Constrain Use the Constrain tool to create pin, drawbead, and blankholder constraints for analysis.





- Create and Edit Materials Based on the System Library
  - Create a material that is based on an existing predefined material in the System Library.





- Create and Edit Materials Based on the System Library
  - Feasibility Ribbon > Setup Tool > Materials > Material Library Tab > Select the material

- Click Materials ribbon under Set Up to open the material library
- Select a material from the material library and right click to add to My Materials
- · Added material can be accessed by right mouse click on the part and assigned

	Material Library My Materials	Name	SAE 12329 HR 3 DDO	Material Library My Materials	Name	CPDO Steel
	4 × 0	Type: Steel	5/12_02025_111_5_0504	<u>ах</u>	Type: Steel	Citibid Steel
		Bastic Plastic FLC     Density:     Young's modulus:     Poisson's ratio:     Vield stress:	7.8E-009 t/mm3 210000 MPa 0.3 234 MPa	Var / Motorals // Motorals // Syntem/Steel/CRDQ Steel - Syntem/Steel/SAE_J2325_HR_3_DDQ	Pastic Plastic FLC Density: Young's modulus: Poisson's ratio: Yield stress:	7.8E-009 t/mm3 210000 MPa 0.3 186 16 MPa
Materials Orient Constrain Setup	S.E., 12340, CR, 1980, Data, Hard           S.E., 12340, CR, 1980, Back, Hard           S.E., 12340, CR, 1980, Data, Feest           S.E., 12340, CR, 2100, Data, Hard           S.E., 12340, CR, 2100, Data, Hard           S.E., 12340, CR, 2100, Data, Hard           S.E., 12340, CR, 2200, Data, Feest           S.E., 12340, CR, 2200, Data, Feest           S.E., 12340, CR, 2200, Data, Feest		201110			100.10 M U
Blank Symmetry Materials Define Blank	SAE_J234U_CR4_2018Lijske_Herd SAE_J2340_CR_3005_HSS SAE_J2340_CR_3007_HSLA SAE_J2340_CR_3007_HSLA SAE_J2340_CR_3007_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_3407_HSLA SAE_J2340_CR_5507_HSLA SAE_J2340_CR_5507_HSLA SAE_J2340_CR_5507_HSLA SAE_J2340_CR_5507_HSLA SAE_J2340_CR_5507_HSLA SAE_J2340_CR_5507_HSLA SAE_J2340_CR_5507_HSLA	•				
			Create Close			Update Close









Materials	×		
Material Library My Materials	Name: Test-20190415		
⊕ ×	Type: Steel		
My Materials System\Steel\CRDQ Steel System\Steel\SAE_J2329_CR_3_DQ System\Steel\SAE_J2340_CR_210A_Dent_Resist System\Steel\SAE_J2340_CR_340S_HSS Steel\Test-20190415	Materials Material Library My Materials My Materials My Materials System \Steel \CRDQ Steel System \Steel \CRDQ Steel System \Steel \SAE_J2340_CR_210A_Dent_Resist System \Steel \SAE_J2340_CR_340S_HSS Steel \Test 20190415 Add to User Material Library Delete from My Materials	Name:       Test-20190415         Tune:       Stanl         Materials       Image: Stanl         Material Library       My Materials         Image: System Steel CRDO Steel       System Steel CRDO Steel         System Steel SAE_J2322_CR_3_DQ       System Steel SAE_J2340_CR_210A_Dent_Resist         System Steel SAE_J2340_CR_340S_HSS       User Steel Test-20190415	Name:         Test-20190415           Type:         Steel           Bastic         Plastic           Plastic         FLC           Density:         7.8E-09 t/mm3           Young's modulus:         210000 MPa           Poisson's ratio:         0.3           Yield stress:         186.16 MPa
Materials			×
Material Libr	ary My Materials	Name: Test-20190415	
· · · · · · · · · · · · · · · · · · ·	6	Type: Steel	~
+ → Ξ >	User ► Steel	Elastic Plastic FLC	
Test-20	0190415	Density: 7.8E-09 t/mm3	
		Young's modulus: 210000 MPa	
		Poisson's ratio: 0.3	
		Yield stress: 186.16 MPa	
19			



▶ 재생 시간: 2분 49초

- Create and Edit Materials from "My Materials" tab
  - Also user can create a material under My Materials tab and assign to part
  - Click on the symbol and Create button to create a new material
  - Enter a Material Name
  - Enter the Elastic, Plastic and FLC data and click Create
  - After creating the material user can also update the values at any time

enal Library My Materials	Name:	UserMat 1
×	Type: Steel	*
Materials	Elastic Plastic FLC	
System\Steel\CRDQ Steel	Density:	7.8E-009 t/mm3
	Young's modulus:	210000 MPa
	Poisson's ratio:	0.3
	Yield stress:	186.16 MPa
		Carata D. Chara

# Elastic

aterial Library My Materials	Name: UserMat1		
×	Type: Steel		*
ly Materials	Elastic Plastic	FLC	
System\Steel\CRDQ Steel	Density:	7.8E-09 t/mm3	
	Young's modulus:	210000 MPa	
	Poisson's ratio:	0.3	
	Yield stress:	186.16 MPa	

Elastic Plastic FLC						
Density:	7.8E-09 t/mm3					
Young's modulus:	210000 MPa					
Poisson's ratio:	0.3					
Yield stress:	186.16 MPa					

# Plastic

My Materials	Name: UserMat1	
	Type: Steel	
wy Materials	Elastic FLC	
	Stress-Strain: Po	wer Law (True)
	Yield stress: 18	6.16 MPa
	Tensile stress: 31	5.78 MPa
	Strength coefficient: 54	9.03 MPa
	Strain hardening: 0.2	22
	Uniform elongation: 0	
	R00: 1.6	ò
	R45: 1.6	ò
	R90: 1.6	ò
	Yield criterion: Hill	1948
	Exponent (m): 2.0	1
	Data Points: ⇒	
	Plots: ¥	



0.2

0.0

0.4

Strain

0.6

### Material Database(2) Material Create

- Create and Edit Materials from "My Materials" tab
  - User can enter the **Plastic data** or **Data Points** (Engineering or True Stress-Strain values based)
  - Once we enter the values and create a material Stress Strain plot gets updated



$$\sigma = (a + barepsilon_p^n) \left(1 + c \ln rac{\dot{arepsilon}}{\dot{arepsilon}_0}
ight) \left(1 - \left(T^*
ight)^m
ight)$$

 $\bigtriangleup$ 

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0.8

- **Create and Edit Material using Stress** ٠ Strain curve data
  - Click My Materials Tab inside materials window
  - Add a material by clicking on the 
     Option
- - Load the excel file to **Data Points** •

Uniaxial tension test data							
Tensile directio n from RD	Young's Modulu s (GPa)	*s <sub>0.2 (W)</sub> (MPa)	*s <sub>1.0 (W)</sub> (MPa)	Tensile Strengt h (MPa)	Uniform Elongati on (%)	R-Value	
00	186	684,2	870,8	1017,2	9,4%	0,691	
15 <sup>0</sup>	187	676,9	862,6	NA	NA	0,760	
30 <sup>0</sup>	186	669,9	854,5	NA	NA	0,888	
45 <sup>0</sup>	191	676,6	863,4	1007,3	9,0%	1,050	
60 <sup>0</sup>	197	685,2	873,8	NA	NA	1,080	
75 <sup>0</sup>	204	691,4	886,3	NA	NA	1,020	
90 <sup>0</sup>	208	701,5	898,0	1052,3	9,4%	0,959	

#### User Table data

Plastic Strain	True stress	
0	670.0813	
0.005	701 2222622	
0.005	781.3333033	
0.01	863.2312874	
0.015	916.8322885	
0.02	955.3279273	
0.025	984.1043743	
0.03	1006.215309	
0.035	1023.609047	
0.04	1037.597375	
0.045	1049.089413	
0.05	1058.726585	
0.055	1066.967202	Ľ
0.06	1074.142058	
0.065	1080.492057	
0.07	1086.194154	
0.075	1091.379477	
0.08	1096.146098	
0.085	1100.568094	
0.09	1104.702016	
0.095	1108.591538	
0.1	1112.270797	
0.11	1119.101303	
0.12	1125.353035	
0.13	1131.13382	
0.14	1136.520361	

laterial Library My Materials	Name:		UserMat1
×	Type:	Steel	~
y Materials	Elastic	Plastic	LC
System\Steel\CRDQ Steel	Stress-	Strain:	Data Points (Tru 👻
Steel/UserMati	Yield st	ress:	670.061 MPa
	Tensile	stress:	992 911 MPa
	Strengt	h coefficient	1320 16 MPa
	Strain h	ardoning:	0.081116
	Uniferen	ardening.	0.001110
	Oniom	reiongation.	10
	RUU:		1.6
	R45:		1.6
	R90:		1.6
	Data F	Points: 🕆	
		True Strain	True Stress
	1	C	670.081 MPa
	2	0.005	5 781.333 MPa
	3	0.01	863.231 MPa
	4	0.015	5 916.832 MPa
	5	0.02	955.328 MPa
	6	0.025	5 984.104 MPa
	7	0.03	3 1006.22 MPa
	8	0.035	5 1023.61 MPa
	9	0.04	1037.6 MPa
	10	0.045	5 1049.09 MPa
	11	0.05	5 1058.73 MPa
	12	0.055	1066.97 MPa
	13	0.06	5 1074.14 MPa
	14	0.065	5 1080.49 MPa
	15	0.07	1086.19 MPa
	16	0.075	5 1091.38 MPa ❤
	Plots:	×	

#### Step 1: 측정 항목 확인

Uniaxial tension test data							
Tensile direction from RD	Young's Modulus (GPa)	*s <sub>0.2 (W)</sub> (MPa)	*s <sub>1.0 (W)</sub> (MPa)	Tensile Strength (MPa)	Uniform Elongati on (%)	R-Value	
0 <sup>0</sup>	<mark>186</mark>	<mark>684,2</mark>	870,8	1017,2	9,4%	<mark>0.691</mark>	
15 <sup>0</sup>	187	676,9	862,6	NA	NA	0.760	
30 <sup>0</sup>	186	669,9	854,5	NA	NA	0.888	
45 <sup>0</sup>	191	676,6	863,4	1007,3	9,0%	<mark>1.050</mark>	
60 <sup>0</sup>	197	685,2	873,8	NA	NA	1.080	
75 <sup>0</sup>	204	691,4	886,3	NA	NA	1.020	
90 <sup>0</sup>	208	701,5	898,0	1052,3	9,4%	<mark>0.959</mark>	

Plastic Strain	True stress
0	670.0813
0.005	781.3333633
0.01	863.2312874
0.015	916.8322885
0.02	955.3279273
0.025	984.1043743
0.03	1006.215309
0.035	1023.609047
0.04	1037.597375
0.045	1049.089413
0.05	1058.726585
0.055	1066.967202
0.06	1074.142058
0.065	1080.492057
0.07	1086.194154
0.075	1091.379477
0.08	1096.146098
0.085	1100.568094
0.09	1104.702016
0.095	1108.591538
0.1	1112.270797
0.11	1119.101303
0.12	1125.353035
0.13	1131.13382
0.14	1136.520361

#### Step 2

- a) Click **My Materials** Tab inside materials window
- b) Add a material by clicking on the



- c) Enter Name and choose Type.
- d) Use **Elastic** tab to fill Elastic material data. By default it is populated with steel data.
- e) Define Youngs Modulus as 186000 Mpa.
- f) Define **Yield stress** as 684 Mpa.
- g) Click Create



#### Step 3

- Enter Plastic Tab a)
- Set Stress Strain: to Data points (True) b)
- Open Data Points, Select a field, C) Right click and Pick Clear All to empty table.

Data Points: A True Strain Clear Selected Clear Selected C	シ			
True Strain True Stress Clear Selected Clear Selec	Data	a Points: 🔅		
1         Clear Selected           2         Clear Selected           3         Clear Selected           4         Selected           5         Selected           6         Selected           7         Selected           9         Selected           10         Selected		True Strain	True Stress	<b>^</b>
2 (Year All 4 5 6 7 7 8 9 10	1	Clea	ar Selected	_
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5 6 7 8 9 10	4			
6 7 8 9 10	5			
7 8 9 10	6			_
9 10 11	8			
10 *	9			
	10			
Plots: ×	Plot	s: ¥		

**Copy Data** (Ctrl+C) from excel file (data from 2 colomns), d) paste (Ctrl+V) in the Data Points selecting the first field.

Plastic Strain	True stress (Pa)
0	670081300
0,005	781333363,3

Fill in data for R0, R45, R90 from the excel file e)

			Materials ::::::::					····· >				
			Material Library N	ly Materials	Name: UserMat1							
User			⊕ ×		Type: Steel							
			My Materials		Elastic Plastic ELC							
Toble date			System\Steel\Cl	RDQ Steel	01	D. D. D. S.	Data Bainta (Trus)					
Table uala			Steel\UserMat1	Stress-Strain:	Data Point	Data Points (True)						
						Yield stress:	670.081 MF	ра				
Pla	astic StraT	rue stress (Pa)				Tensile stress:	992.911 M	Ра				
	0	670081300				Strongth coofficio	+ 1320 16 M	20				
	0.005	781333363.3				Strength coefficien	1520.10101	a				
	0.01	863231287.4				Strain hardening:	0.081116					
	0.015	916832288.5			_	Uniform olongatio	n: 0					
	0.02	955327927.3			<b>[</b>	D00	0.691					
	0.025	984104374.3				1100.	0.031					
	0.03	1006215309				R45:	1.05					
	0.035	1023609047				R90:	0.959					
	0.04	1037597375		Paste from y	ds 🛛							
	0.045	1049089413		1 4010 1101117		Data Points: 🚿						
	0.05	1058726585				True Stra	in Tr	ue Stress				
	0.055	1066967202					0	670.081 MPa				
	0.06	1074142058					005	791 222 MDo				
Þ	0.065	1080492057				2 0	005	701.333 MPa				
	0.07	1086194154				3	0.01	863.231 MPa				
	0.075	1091379477				4 0	015	916.832 MPa				
	0.08	1096146098				5	0.02	955.328 MPa				
	0.085	1100568094				6 0	025	984.104 MPa				
	0.09	1104/02016				7	0.03	1006.22 MPa				
	0.095	1108591538				8 0	035	1023.61 MPa				
	0.11	11122/0/9/				9	0.04	1037.6 MPa				
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	0.15	1146326115										
	0.17	1150824639					Update	Close				
	0.18	1155094031										
	0.19	1159158171										

#### Step 4

- a) Enter FLC Tab.
- b) Set the FLC to Calculate.
- c) Enter Thickness as 1.2 mm.
- d) Click on Update .
- e) Select material, Right Click and Pick **Add to user Material Library** to save the material to your library (optional).
- f) Click Close to dismiss the material dialog

FLC0 = ( 0.23 + 0.146 \* t ) \* n / 0.21 )



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							4 Uniaxial tension test data								
							5								
							7	Iensile	Young's	* (T0.2 (W)	* 0 1.0 (W)	Tensile	Uniform	P.Value	
							8	from RD	(GPa)	(MPa)	(MPa)	(MPa)	n (%)		
							9	0°	186	684.2	870.8	1017.2	9.4%	0.691	
							10	45°	191	676.6	863.4	1007.3	9.0%	1.050	
							11	90°	208	701.5	898.0	1052.3	9.4%	0.959	
							12								
							13								
							14	Plastic Str	True stress (Pa	)					
							15	C	67008130	D					
							16	0.005	781333363.	3					
							17	0.01	863231287.4	4					
							18	0.015	916832288.						
							20	0.025	933327927.						
Property Editor							21	0.02	100621530						
Name Value							22	0.035	102360904	7					
							23	0.04	103759737	5					
							24	0.045	104908941	3					
							25	0.05	105872658	5					
							26	0.055	106696720	2					
							27	0.06	107414205	8					
							28	0.065	108049205						
							29	0.07	1086194154	1					
							31	0.075	109137947	2					
							32	0.085	110056809	1					
	Z						33	0.09	110470201	5					
	Y						34	0.095	110859153	3					
							35	0.1	111227079	7					
							36	0.11	111910130	3					
							37	0.12	112535303	5					
							38	0.13	1131133820	D					
							39	0.14	113652036	1					
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<sup>▶</sup> 재생시간: 2분 21초



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# **QUESTIONS & ANSWERS**

